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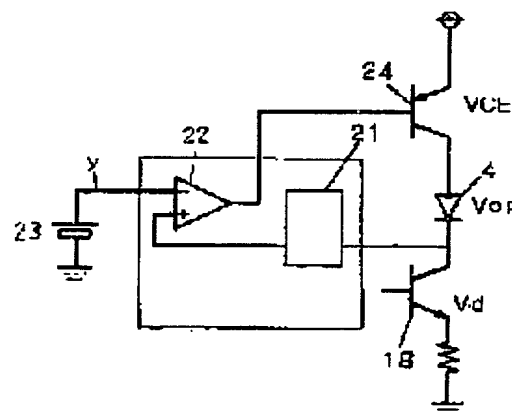
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(54) SEMICONDUCTOR LASER DRIVER AND DRIVING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To drive a multilevel semiconductor laser current stably with high accuracy at high speed by keeping a voltage being applied to the output section of a semiconductor laser driver at a constant level and setting the power supply voltage to minimize a voltage being applied to the output section within the operable range of the driver.

SOLUTION: When a drive current is drawn out from the cathode side of a semiconductor laser 4, a voltage detecting section 21 detects the collector voltage of a transistor 18 at the output section of a laser driver. Output signal from the voltage detecting section 21 is the voltage comparison section 22 and compared with the voltage of a reference voltage supply 23 and comparison result is fed back to a power supply transistor 24 in order to control the collector voltage of the transistor 18 at a constant level during recording, erasing and reproducing operations. When the collector voltage of the transistor 18 is set at a minimum operable level, i.e., a minimum level causing no bottoming saturation, generation of heat in the laser drive current output section can be kept at a minimum level.



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CLAIMS

[Claim(s)]

[Claim 1] With the semiconductor laser driving gear for performing playback of data, and record of data using an optical disk As opposed to the highest frequency f when carrying out light modulation of the semiconductor laser to the shape of a pulse ($f > 0$) Build-up-time T_a ($T_a > 0$) of said light modulation wave and the relation of fall-time T_b ($T_b > 0$) $T_a < 0.5 \times 0.5 / f$, The semiconductor laser driving gear characterized by approaching the conditions of $5 \text{ cm} > L > 0$ in the distance L between said semiconductor laser driving gears and said semiconductor laser so that it may be set to $T_b < 0.5 \times 0.5 / f$.

[Claim 2] Said semiconductor laser driving gear is a semiconductor laser driving gear according to claim 1 characterized by being carried in the same moving part as an optical pickup.

[Claim 3] Said semiconductor laser driving gear N individual (N P laser power setting signals (P is the natural number below N) chosen with the change timing signal input section and said change timing signal of N individual for choosing respectively the laser power setting signal of the laser power setting signal input part of natural number), and said N -ary The semiconductor laser driving gear according to claim 2 which has the current source which supplies a drive current to semiconductor laser according to said P laser power setting signals added by the signal adder unit and said signal adder unit for adding.

[Claim 4] The laser power setting signal of said N individual is a semiconductor laser driving gear according to claim 3 characterized by taking a current input gestalt.

[Claim 5] It is the semiconductor laser driving gear according to claim 3 characterized by the M timing signal input sections (M being the natural number below N) having the input gestalt of a differential mold among the change timing signal input means of said N individual.

[Claim 6] The semiconductor laser driving gear according to claim 3 which has the armature-voltage control section of the power supply section and power supply section for controlling the electrical-potential-difference value concerning the semiconductor laser drive output section of said semiconductor laser driving gear to constant value as compared with a reference value.

[Claim 7] The semiconductor laser driving gear according to claim 6 characterized by controlling said power supply section so that the electrical-potential-difference value concerning said semiconductor laser driving gear output section turns into the minimum value of said semiconductor laser driving gear output section which can be operated.

[Claim 8] Said power supply section is a semiconductor laser driving gear according to claim 6 characterized by being prepared outside the same moving part as said optical pickup.

[Claim 9] By the semiconductor laser drive approach for performing playback of data, and record of data using an optical disk As opposed to the highest frequency f when carrying out light modulation of the semiconductor laser to the shape of a pulse ($f > 0$) Build-up-time T_a ($T_a > 0$) of said light modulation wave and the relation of fall-time T_b ($T_b > 0$) $T_a < 0.5 \times 0.5 / f$, The semiconductor laser drive approach characterized by approaching the conditions of $5 \text{ cm} > L > 0$ in the distance L between said semiconductor laser driving gears and said semiconductor laser so that it may be set to $T_b < 0.5 \times 0.5 / f$.

[Claim 10] The current mechanical component of said semiconductor laser is the current drive approach according to claim 9 characterized by being carried in the same moving part same with said semiconductor laser as said optical pickup.

[Claim 11] The semiconductor laser drive approach according to claim 10 which inputs the laser power setting signal of N individual (N is the natural number) by said current drive approach, chooses the laser power setting signal of said N individual with the change timing signal of N individual, adds said P selected laser power setting signals (P is the natural number below N), and supplies the drive current according to said added setting signal to said semiconductor laser.

[Claim 12] The laser power drive approach according to claim 11 characterized by making the laser power

setting signal of said N-ary into a current input.

[Claim 13] The semiconductor laser drive approach according to claim 11 characterized by transmitting M change timing signals (M being the natural number below N) with a differential signal among the change timing signals of said N individual.

[Claim 14] The semiconductor laser drive approach according to claim 11 which observes the electrical potential difference of said semiconductor laser drive output section, controls the electrical potential difference of the power supply section which supplies a current to said semiconductor laser and the drive output section based on said observed value, and controls the electrical potential difference of said semiconductor laser drive output section to become a fixed electrical potential difference.

[Claim 15] The semiconductor laser drive approach according to claim 14 which controls the supply voltage to said semiconductor laser drive output section to become the minimum value of said drive output section which can be operated.

[Claim 16] Said power supply section is the semiconductor laser drive approach according to claim 14 characterized by supplying a current to the semiconductor laser and semiconductor laser current mechanical component which were prepared in the field outside the same moving part as said optical pickup, and were carried in the same moving part as an optical pickup.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the semiconductor laser control carried in the optical pickup of an optical disk unit.

[0002]

[Description of the Prior Art] An optical disk unit emits light in the semiconductor laser carried in the optical pickup. The reflection factor of the pit which condenses a feeble playback light on a disk at the time of playback, and is recorded on the disk, Phase contrast, a deflection angle, etc. are detected and read, semiconductor laser is made to emit light by power higher than the time of playback at the time of record, laser power is modulated according to the information to record, it records on a disk, laser power almost near at the time of record is irradiated on a disk at the time of elimination, and the Records Department is eliminated.

[0003] For example, fundamentally, in record to a phase-change optical disk, binary [of peak power and bias power] is switched, it records a mark in the peak power section, and eliminates a record mark in the bias power section.

[0004] However, in order to form the record mark stabilized in fact, it is insufficient, and two or more values more than binary need to be laser power switched of binary switching because of the purpose which equalizes the heating value applied to the mark which should be recorded, or the purpose which adjusts the heat balance of an edge always [mark] as shown in drawing 1 .

[0005] Record playback of an optical disk is also accelerated in recent years, and rapidity has come to be needed more also for the switching operation of the above-mentioned semiconductor laser.

[0006] When it is going to realize the record pulse shown in drawing 1 at the time of high-speed record and the pulse shape of semiconductor laser is not fully accelerated, as shown in drawing 2 , laser power will not reach to desired peak value, but the heating-value imbalance to a record mark will arise, and a record mark will be distorted.

[0007] Moreover, in the PWM record which has information in the edge before and after a record mark, since it is necessary to control the edge location of a record mark correctly, the record pulse with shorter standup of a record pulse and fall time is demanded.

[0008]

[Problem(s) to be Solved by the Invention] By the optical pickup which carried the semiconductor laser adopted conventionally, and the method which the semiconductor laser driving gear has separated, the drive current of semiconductor laser is usually transmitted with a flexible cable etc. In this case, the switching characteristic of a drive current gets worse with distributed constants, such as parasitic capacitance of a flexible cable.

[0009] That is, aggravation of this switching characteristic serves as evil for accelerating an optical disk unit.

[0010] This invention relates to power-saving for solving the problem of the heat centralization generated with the improvement to the above-mentioned evil, and an improvement.

[0011] Drawing 3 indicates build-up-time T_r of the semiconductor laser drive current when switching semiconductor laser in the shape of a pulse, and the relation of the fall time T_f to be the semiconductor laser of an optical disk unit, and the capacity component which is parasitic on the conductor between driving gears etc.

[0012] Before the high frequency component of the pulse current transmitted is transmitted to semiconductor laser, it is bypassed through capacity, and build-up-time T_r of a driving pulse wave of

semiconductor laser and the fall time T_f become large as a capacity component will increase, if its attention is paid to the above-mentioned capacity component. That is, the record pulse which became blunt as shown in drawing 2 is approached.

[0013] Temporarily, if the pulse of the highest frequency f_1 is needed in a semiconductor laser driving pulse, as for pulse width, $0.5/f_1$ becomes minimum pulse width. therefore, conditions which do not have the amplitude fall of a driving pulse in the pulse of a frequency f_1 $T_r \ll 0.5 \times 0.5/f_1$ $T_f \ll 0.5 \times 0.5/f_1$ (formula 1)

It becomes.

[0014] For example, the highest frequency = for 60MHz pulse switching implementation, it is required from a formula 1 that both T_r and T_f should be 4.16 or less ns.

[0015] In order to realize T_r and $T_f < 4.16$ ns from the experimental result shown in drawing 3, 10pF or less can say that a parasitic capacitance component is required. In order to fulfill these conditions, it is required to contiguity-ize distance between semiconductor laser and a laser mechanical component within 5cm.

[0016] Therefore, in order to attain high-speed laser switching, for the distributed constant between a laser driving gear and semiconductor laser, and the purpose which mainly reduces a capacity component, between a laser driving gear and semiconductor laser is made to approach, namely, it is necessary to carry a laser driving gear on the optical pickup in which semiconductor laser is included. Or it is necessary for the same moving part as an optical pickup to attach a laser driving gear. However, it is the problem of the heat generated from semiconductor laser and a laser driving gear to become a problem in this case.

[0017] At the time of data logging to an optical disk, the semiconductor laser drive current I_{op} is $T_d = K_1 \times V_d \times I_{op}$, when the electrical potential difference which amounts to several 100mA and is built over the driving gear output section is set to V_d and a proportionality constant is set to K_1 . (formula 2)

***** occurs in a driving gear.

[0018] Since a laser driving gear and semiconductor laser need to approach in order to make small effect of a parasitic capacitance division-into-equal-parts cloth constant, and it is necessary to arrange them, they conduct the heat generated with the driving gear also to semiconductor laser, as mentioned above.

[0019] It gets worse, more drive currents I_{op} are needed, and the relation (differential effectiveness) of the laser luminescence power P to the drive current I_{op} accelerates the temperature rise of a driving gear from a formula 1 further, so that the drive properties of semiconductor laser differ greatly and serve as an elevated temperature with temperature.

[0020] Moreover, itself is a source of generation of heat, and semiconductor laser is V_{op} and a proportionality constant about the operating voltage of semiconductor laser K_2 , then $T_{ld} = K_2 \times V_{op} \times I_{op}$ (formula 3)

It becomes *****. That is, it is the temperature rise of K_3 , then semiconductor laser about the conductivity of the heat from a drive circuit to semiconductor laser. $T_{ld} = K_2 \times V_{op} \times I_{op} + K_3 \times K_1 \times V_d \times I_{op}$ (formula 4)

It becomes.

[0021]

[Means for Solving the Problem] Control of control of the drive current I_{op} , proportionality constants K_1 and K_2 , and thermal conductivity K_3 and control of the electrical potential differences V_d and V_{ld} concerning the driving gear output section can be considered as a solution means of the above trouble.

[0022] I_{op} is the property of a semiconductor laser proper and proportionality constants K_1 , K_2 , and K_3 are dependent on an optical pickup configuration and a thermal design. Moreover, although V_{op} is also changed according to the drive current I_{op} , the amount of fluctuation is decided by diode voltage and internal series resistance, and is the value of a semiconductor laser proper fundamentally.

[0023] Therefore, generation of heat of the optical head section is controlled by controlling the electrical potential difference V_d concerning the laser driving gear output section.

[0024] The power supply section which controls the electrical potential difference supplied to the laser driving gear output section in order to control V_d is prepared, and the electrical potential difference of the laser driving gear output section is supervised, it controls by feeding back the difference to a power supply section as compared with the electrical potential difference used as criteria so that V_d can always maintain constant value, and further, within limits which can be drive operated, the laser driving gear output section sets up the electrical potential difference of a power supply section so that V_d may become the minimum value.

[0025] The above-mentioned power supply section installs in locations other than the optical pickup in which semiconductor laser and a semiconductor laser driving gear are carried. That is, the surplus exoergic section is isolated in the location which does not participate in the semiconductor laser section thermally.

[0026] Even if it furthermore changes the supply voltage of an optical disk unit with fluctuation of AC Rhine electrical potential difference, fluctuation of a load, other variations, etc., Vd of the semiconductor laser driving gear output section is kept constant, and generation of heat within an optical pickup stops being always related to these fluctuation.

[0027] Thus, generation of heat in the optical pickup section can always be controlled by maintaining the electrical potential difference Vd concerning the laser driving gear output section at the minimum electrical potential difference which can be operated in the minimum condition, and the high speed semiconductor laser drive stabilized as a result can be realized.

[0028]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained.

[0029] The system configuration Fig. of an optical disk record regenerative apparatus is shown in drawing 4. The roll control of the optical disk 1 is carried out in the fixed direction by the spindle motor 2. 3 is an optical pickup for performing record playback of data to an optical disk 1.

[0030] Drawing 5 contains the laser driving gear with the block diagram of an optical pickup 3.

Semiconductor laser 4 outputs laser beam a according to the drive current Iop supplied from the laser driving gear 5. Laser beam a outputted from semiconductor laser 4 is made into parallel light with a collimate lens 6, it passes a beam splitter 7 and incidence is carried out to an objective lens 8. With an objective lens 8, a laser beam is condensed and the focus of the condensing spot is carried out to the data-logging side of an optical disk 1.

[0031] The laser beam reflected by the recording surface turns into parallel light with an objective lens 8 again, changes an optical path and is condensed by the beam splitter 7 at a photodetector 9.

[0032] The reflected light of an optical disk 1 is changed into an electrical signal by the photodetector 9, and is inputted into the servo block 10 of drawing 4. Focal control and tracking control are made according to the electrical signal of a photodetector 9.

[0033] b, c, d and e, i.e., focal signal +, which are shown by drawing 4 and drawing 5, focal signal -, tracking signal +, and tracking signal - are inputted into the servo block 10. With a servo block, a tracking error signal is made from focal error signal and tracking signal + and tracking signal - from focal signal + and focal signal -.

[0034] Current amplification of a focal error signal and the tracking error signal is carried out, they are told to the actuator 11 of an optical pickup 3, and position control is carried out so that the outgoing radiation light of an optical pickup 3 may condense on the recording surface of an optical disk 1.

[0035] Moreover, the focal signals b and c and the tracking signals d and e which are outputted from a photodetector 9 are inputted into the regenerative-signal processing block 12 at coincidence, and the signal component of the high frequency band in a signal is detected as information data currently recorded as a pit on the optical disk.

[0036] In the record signal-processing block 13, modulation, laser power which carries out format conversion and which is shown later, and timing control are performed for external input data to optical disks.

[0037] The Maine control block 14 is controlling the above regenerative-signal processing block 13 and the record signal-processing block 12.

[0038] The power and the record mark of semiconductor laser when recording a mark on a phase-change optical disk as an example are shown in drawing 6. The peak power 1 (PEAK1) and the peak power 2 (PEAK2) are the power for forming a record mark on an optical disk 1. The bias power 1 (BIAS1) is the power for eliminating the mark recorded on the substrate. The bias power 2 (BIAS2) is the power for reducing heat are recording of a mark.

[0039] Moreover, about the area which is not recorded, playback power (READ) is always turned on.

[0040] That is, this example means needing a laser power setup of five values for data logging to an optical disk, and playback.

[0041] The block diagram of a semiconductor laser driving gear is shown in drawing 7. A playback power programmed-current input (IINRD), the peak power 1 programmed-current input (IINPK1), the peak power 2 programmed-current input (IINPK2), the bias power 1 programmed-current input (IINBS1), and the bias power 2 programmed-current input (IINBS2) are inputted into the current input buffer section 15 from the record signal-processing block 13, respectively.

[0042] By taking a current input gestalt, a power setting signal can make the impedance of an electrical transmission way small, and makes effect of a noise the minimum in the long transmission line by a flexible cable etc. In addition, as for Above IINRD, and IINPK1, IINPK2, IINBS1 and IINBS2, it is also possible for a current input to take not conditions but a volt input gestalt absolutely.

[0043] Timing signals are a playback power timing signal (RDMD), peak power 1 timing signal (PK1MD+, PK1MD-), peak power 2 timing signal (PK2MD+, PK2MD-), bias power 1 timing signal (BS1MD+, BS1MD-), and bias power 2 timing signal (BS2MD).

[0044] A power timing signal functions as an enable signal to the power programmed current inputted into the current buffer section 15 in a current driving gear.

[0045] The switching timing of the timing signal for realizing laser luminescence shown by drawing 6 is shown in drawing 8. An active state and bias power 2 timing-signal BS2MD are also always active states in record or elimination area between playback power luminescence time amount, and playback power timing signal RDMD seldom needs rapidity as a switching speed. Therefore, in this example, the timing transmission system of the single end is taken about the above-mentioned 2 timing signals, and it is inputted into the single end logic input section 16.

[0046] In drawing 8, BS2MD makes L level the active state. Peak power 1 timing-signal PK1MD, peak power 2 timing-signal PK2MD, and bias power 1 timing-signal BS1MD are a timing signal which needs high-speed switching at the time of record mark formation, take a differential gestalt, and are inputted into the differential logic input section shown in drawing 7 as drawing 8 shows them. The signal after the operation of the control signal of a difference input is defined as follows, respectively.

[0047]

$PK1MD = (PK1MD+) - (PK1MD-)$ (formula 5)

$PK2MD = (PK2MD+) - (PK2MD-)$ (formula 6)

$BS1MD = (BS1MD+) - (BS1MD-)$ (formula 7)

If PK1MD of drawing 8 is taken for an example, PK1MD+ will make an active state the time of H level and PK1MD- being L level. It is possible to cancel a penetration noise component also in the long transmission line by a flexible cable etc. for the data transmission of a differential gestalt. moreover -- since the crossing point of a positive logic input and a negative logic input serves as an edge location of the result of an operation, ***** change of duty arises by voltage variation and the noise -- final difference -- affecting the duty after an operation decreases.

[0048] By the optical disk record approach which adopts as the die length of a record mark the PWM record which gives information, the duty shelf life of a record pulse is very important.

[0049] Under a definition, the relation of Iop is indicated to be each control line as follows above.

$I_{op} = G \times (RDMD \times IINRD + PK1MD \times IINPK1 + PK2MD \times IINPK2 + BS1MD \times IINBS1 + BS2MD \times IINBS2)$ (formula 8)

It becomes. G is gain of a current mechanical component shown in 18 of drawing 7.

[0050] a timing signal be make into a 2 signal differential type, distribute and it depend until it adopt an addition method as the creation of a scale and a semiconductor laser driving signal and finally carry out the addition composition of the improvement in precision by increase the reinforcement for a noise, and in order to deal with and process each element current of small level, it become that it be advantageous in calorific value, a switching characteristic, etc. in the buffer sections 15, 16, and 17 about the record and the elimination actuation which need a rapidity for control timing as mentioned above.

[0051] Drawing 9 and drawing 10 are drawings in which the configuration of the output section 18 of a semiconductor laser current driving gear was simplified and described.

[0052] Drawing 9 shows the method which supplies the drive current Iop in the direction sucked out of the cathode side of semiconductor laser 4, and drawing 10 shows the method which supplies the drive current Iop in the direction slushed from the anode side of semiconductor laser 4.

[0053] The laser drive current Iop is several 100mA order, and depends the great portion of power consumed on an optical pickup on the laser drive current Iop. The power consumption on an optical pickup 3 is $P = VCC \times I_{op}$. (formula 9)

It can come out and express. VCC is supply voltage, and when VCC varies in the largest direction, power consumption serves as max. The items of VCC are the operating voltage Vop of semiconductor laser 4, and the operating voltage Vd of the drive output section 18 as they are shown in drawing 9, and they are $VCC = V_{op} + V_d$. (formula 10)

It becomes. Although it is common to be transmitted by the flexible cable 20 from a main part 19 as VCC is shown in drawing 11, and the voltage drop on a flexible cable etc. is considered, in this example, it is omitting for simplification. In addition, the regenerative-signal processing block 12, the record signal-processing block 13, the control block, etc. are mounted in the main part 19.

[0054] Moreover, the operating voltage Vop of semiconductor laser 4 changes with the operating currents Iop rather than is fixed. Generally it is diode voltage Vld, the internal resistance Rs, then $V_{op} = V_{ld} + I_{op} \times R_s$ in semiconductor laser. (formula 11)

It is expressed. As mentioned above, it is if a formula 9 is rewritten. $P = (V_{op} + V_d) \times I_{op}$ (formula 12)

$= V_{Id} + I_{op} R_s + V_{dx} I_{op}$ (formula 13)

It becomes.

[0055] The relation of the drive current I_{op} is indicated to be the output light power of semiconductor laser 4 to drawing 12.

[0056] Semiconductor laser emits light in the power proportional to the drive current I_{op} by making differential effectiveness η into an inclination to the current more than a threshold current I_{th} . The above-mentioned property of semiconductor laser changes with degradation of operating environment temperature and the component by long duration use.

[0057] Although it is the graph which I_{th1} and η_1 are ordinary temperature, respectively, and showed the relation of the output laser power pair drive current of the initial state of duration of service, the time of an elevated temperature, or after prolonged use, it shifts to the graph shown by I_{th2} and η_2 . That is, a drive current value required to carry out outgoing radiation of the fixed laser power P_1 is set to I_{op1} by the former, and is set to I_{op2} ($I_{op1} < I_{op2}$) by the latter. Generation of heat of the laser driving gear 5 increases, and the temperature of semiconductor laser 4 rises as the formula 4 showed from the formula 2, when the drive current I_{op} increased. If temperature rises, there will be a possibility of leading to vicious circle of needing the still bigger drive current I_{op} , and power-saving on an optical pickup 3 will become important.

[0058] Although it is more effective in power saving of an optical head than a formula 9 and a formula 13 to make the drive current I_{op} small, the dependence to a semiconductor laser component is high, and control is difficult for a semiconductor laser drive current, the temperature characteristic, and secular change.

[0059] Therefore, power-saving becomes possible by controlling VCC from a formula 9, i.e., controlling the electrical potential difference V_d built over the laser driving gear output section from a formula 12.

[0060] Drawing 13 and drawing 14 are the circuits of the laser driving gear output section which incorporated the above-mentioned power-saving. Drawing 13 shows the case where it is based on the laser drive approach of the method which pulls out the drive current I_{op} from the cathode side of the semiconductor laser 4 shown by drawing 9. The electrical-potential-difference detecting element 21 detects the collector voltage of the transistor 18 of the laser driving gear output section.

[0061] It is DC at the time of playback, and at the time of elimination, the collector current of a transistor 18 is a pulse-like at the time of record, and it is [it is a pulse-like or] DC. Therefore, the gate mold electrical-potential-difference detection equipment which synchronized with the period when the drive current of the peak power 2 at the time of record, the bias power 1 at the time of elimination, and each lead power at the time of playback is flowing as one example as an electrical-potential-difference detecting element 21 is suitable.

[0062] The output signal of the electrical-potential-difference detecting element 21 is the electrical-potential-difference comparator 22, it is compared with the electrical potential difference of the source 23 of reference voltage, and a comparison result is fed back to the power supply section transistor 24, and the collector voltage of a transistor 18 is always controlled by this example by the fixed electrical potential difference in each at the time of record, elimination, and playback.

[0063] If the collector voltage of a transistor 18 is set as the minimum value at the minimum value which can be operated, i.e., the range which does not carry out bottoming saturation, the calorific value in the laser drive current-output section is maintainable to min.

[0064] The above can also change the source 23 of reference voltage to the optimal value to each mode of record, elimination, and playback, although the source 23 of reference voltage is made into the fixed electrical potential difference.

[0065] Drawing 14 is the example which incorporated power-saving in the laser drive approach of the method which slashes the drive current I_{op} from the anode side of the semiconductor laser 4 shown by drawing 10. The electrical-potential-difference detecting element 21 detects the collector voltage of the drive transistor 18 like the case of drawing 13, and the output of the electrical-potential-difference detecting element 21 is compared with the electrical potential difference of the source 23 of reference voltage by the electrical-potential-difference comparator 22, and feeds back the result to the power supply section transistor 24.

[0066] Since the emitter electrical potential difference of the power supply section transistor 24 is the supply voltage of an optical disk unit, it produces variation, but since the source 23 of reference voltage consists of what has few voltage variation called a band gap, its collector voltage of a transistor 18 is stable in drawing 13, also to a source effect.

[0067] Fluctuation part ΔPP of the power consumption of the transistor 24 by fluctuation part ΔV_{CE} of collector voltage V_{CE} of the power supply section transistor 24 is $\Delta PP = \Delta V_{CE} \times I_{op}$ (formula 14)

It becomes. Therefore, the power supply section transistor 24 brings a result which drives away a heat source to a main part from on an optical pickup also to a part for the line voltage variation of an optical disk unit by arranging in the location 19 separated from the optical pickup, for example, the main part shown in drawing 11.

[0068] VCC shown by the formula 9 serves as a collector voltage of the power supply section transistor 24, and is a collector voltage VC, then $P = V_C \times I_{op}$ (formula 15)

On the other hand, since it is $V_C = V_{op} + V_d$, it is from a formula 14. $P = (V_{op} + V_d) \times I_{op}$ (formula 16)
 $= V_{Id} + I_{op} \times R_s + V_d \times I_{op}$ (formula 17)

It becomes. Since V_{op} , V_{Id} , and R_s are the values of semiconductor laser 3 proper and do not change, it turns out that the power consumption P of an optical pickup 3 is not influenced of a source effect.

[0069] Moreover, reduction of the power consumption on an optical head is attained a passage clear from formulas 16 and 17 by adjusting the electrical potential difference of the source 23 of reference voltage so that the laser driving gear output section electrical potential difference V_d may serve as the minimum value which can be operated.

[0070]

[Effect of the Invention] As mentioned above, a laser driving gear can be arranged like this example on the pickup in which semiconductor laser is included, generation of heat on an optical pickup can be suppressed to the minimum by adjusting the electrical potential difference V_d concerning the laser driving gear output section to the minimum value which can be operated, and it becomes possible to accelerate a multiple-value semiconductor laser current drive to stability with high precision. That is, more nearly high-speed record playback is realizable.

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the semiconductor laser control carried in the optical pickup of an optical disk unit.

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PRIOR ART

[Description of the Prior Art] An optical disk unit emits light in the semiconductor laser carried in the optical pickup. The reflection factor of the pit which condenses a feeble playback light on a disk at the time of playback, and is recorded on the disk, Phase contrast, a deflection angle, etc. are detected and read, semiconductor laser is made to emit light by power higher than the time of playback at the time of record, laser power is modulated according to the information to record, it records on a disk, laser power almost near at the time of record is irradiated on a disk at the time of elimination, and the Records Department is eliminated.

[0003] For example, fundamentally, in record to a phase-change optical disk, binary [of peak power and bias power] is switched, it records a mark in the peak power section, and eliminates a record mark in the bias power section.

[0004] However, in order to form the record mark stabilized in fact, it is insufficient, and two or more values more than binary need to be laser power switched of binary switching because of the purpose which equalizes the heating value applied to the mark which should be recorded, or the purpose which adjusts the heat balance of an edge always [mark] as shown in drawing 1.

[0005] Record playback of an optical disk is also accelerated in recent years, and rapidity has come to be needed more also for the switching operation of the above-mentioned semiconductor laser.

[0006] When it is going to realize the record pulse shown in drawing 1 at the time of high-speed record and the pulse shape of semiconductor laser is not fully accelerated, as shown in drawing 2, laser power will not reach to desired peak value, but the heating-value imbalance to a record mark will arise, and a record mark will be distorted.

[0007] Moreover, in the PWM record which has information in the edge before and after a record mark, since it is necessary to control the edge location of a record mark correctly, the record pulse with shorter standup of a record pulse and fall time is demanded.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, a laser driving gear can be arranged like this example on the pickup in which semiconductor laser is included, generation of heat on an optical pickup can be suppressed to the minimum by adjusting the electrical potential difference V_d concerning the laser driving gear output section to the minimum value which can be operated, and it becomes possible to accelerate a multiple-value semiconductor laser current drive to stability with high precision. That is, more nearly high-speed record playback is realizable.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the optical pickup which carried the semiconductor laser adopted conventionally, and the method which the semiconductor laser driving gear has separated, the drive current of semiconductor laser is usually transmitted with a flexible cable etc. In this case, the switching characteristic of a drive current gets worse with distributed constants, such as parasitic capacitance of a flexible cable.

[0009] That is, aggravation of this switching characteristic serves as evil for accelerating an optical disk unit.

[0010] This invention relates to power-saving for solving the problem of the heat centralization generated with the improvement to the above-mentioned evil, and an improvement.

[0011] Drawing 3 indicates build-up-time T_r of the semiconductor laser drive current when switching semiconductor laser in the shape of a pulse, and the relation of the fall time T_f to be the semiconductor laser of an optical disk unit, and the capacity component which is parasitic on the conductor between driving gears etc.

[0012] Before the high frequency component of the pulse current transmitted is transmitted to semiconductor laser, it is bypassed through capacity, and build-up-time T_r of a driving pulse wave of semiconductor laser and the fall time T_f become large as a capacity component will increase, if its attention is paid to the above-mentioned capacity component. That is, the record pulse which became blunt as shown in drawing 2 is approached.

[0013] Temporarily, if the pulse of the highest frequency f_1 is needed in a semiconductor laser driving pulse, as for pulse width, $0.5/f_1$ becomes minimum pulse width. therefore, conditions which do not have the amplitude fall of a driving pulse in the pulse of a frequency f_1 $T_r \ll 0.5 \times 0.5/f_1$ $T_f \ll 0.5 \times 0.5/f_1$ (formula 1)

It becomes.

[0014] For example, the highest frequency = for 60MHz pulse switching implementation, it is required from a formula 1 that both T_r and T_f should be 4.16 or less ns.

[0015] In order to realize T_r and $T_f < 4.16$ ns from the experimental result shown in drawing 3 , 10pF or less can say that a parasitic capacitance component is required. In order to fulfill these conditions, it is required to contiguity-ize distance between semiconductor laser and a laser mechanical component within 5cm.

[0016] Therefore, in order to attain high-speed laser switching, for the distributed constant between a laser driving gear and semiconductor laser, and the purpose which mainly reduces a capacity component, between a laser driving gear and semiconductor laser is made to approach, namely, it is necessary to carry a laser driving gear on the optical pickup in which semiconductor laser is included. Or it is necessary for the same moving part as an optical pickup to attach a laser driving gear. However, it is the problem of the heat generated from semiconductor laser and a laser driving gear to become a problem in this case.

[0017] At the time of data logging to an optical disk, the semiconductor laser drive current I_{op} is $T_d = K_1 \times V_d \times I_{op}$, when the electrical potential difference which amounts to several 100mA and is built over the driving gear output section is set to V_d and a proportionality constant is set to K_1 . (formula 2)

***** occurs in a driving gear.

[0018] Since a laser driving gear and semiconductor laser need to approach in order to make small effect of a parasitic capacitance division-into-equal-parts cloth constant, and it is necessary to arrange them, they conduct the heat generated with the driving gear also to semiconductor laser, as mentioned above.

[0019] It gets worse, more drive currents I_{op} are needed, and the relation (differential effectiveness) of the laser luminescence power P to the drive current I_{op} accelerates the temperature rise of a driving gear from a formula 1 further, so that the drive properties of semiconductor laser differ greatly and serve as an

elevated temperature with temperature.

[0020] Moreover, itself is a source of generation of heat, and semiconductor laser is V_{op} and a proportionality constant about the operating voltage of semiconductor laser K_2 , then $T_{ld}=K_2 \times V_{op} \times I_{op}$ (formula 3)

It becomes *****. That is, it is the temperature rise of K_3 , then semiconductor laser about the conductivity of the heat from a drive circuit to semiconductor laser. $T_{ld}=K_2 \times V_{op} \times I_{op} + K_3 \times K_1 \times V_{dx} \times I_{op}$ (formula 4)

It becomes.

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MEANS

[Means for Solving the Problem] Control of control of the drive current I_{op} , proportionality constants $K1$ and $K2$, and thermal conductivity $K3$ and control of the electrical potential differences V_d and V_{ld} concerning the driving gear output section can be considered as a solution means of the above trouble. [0022] I_{op} is the property of a semiconductor laser proper and proportionality constants $K1$, $K2$, and $K3$ are dependent on an optical pickup configuration and a thermal design. Moreover, although V_{op} is also changed according to the drive current I_{op} , the amount of fluctuation is decided by diode voltage and internal series resistance, and is the value of a semiconductor laser proper fundamentally.

[0023] Therefore, generation of heat of the optical head section is controlled by controlling the electrical potential difference V_d concerning the laser driving gear output section.

[0024] The power supply section which controls the electrical potential difference supplied to the laser driving gear output section in order to control V_d is prepared, and the electrical potential difference of the laser driving gear output section is supervised, it controls by feeding back the difference to a power supply section as compared with the electrical potential difference used as criteria so that V_d can always maintain constant value, and further, within limits which can be drive operated, the laser driving gear output section sets up the electrical potential difference of a power supply section so that V_d may become the minimum value.

[0025] The above-mentioned power supply section installs in locations other than the optical pickup in which semiconductor laser and a semiconductor laser driving gear are carried. That is, the surplus exoergic section is isolated in the location which does not participate in the semiconductor laser section thermally.

[0026] Even if it furthermore changes the supply voltage of an optical disk unit with fluctuation of AC Rhine electrical potential difference, fluctuation of a load, other variations, etc., V_d of the semiconductor laser driving gear output section is kept constant, and generation of heat within an optical pickup stops being always related to these fluctuation.

[0027] Thus, generation of heat in the optical pickup section can always be controlled by maintaining the electrical potential difference V_d concerning the laser driving gear output section at the minimum electrical potential difference which can be operated in the minimum condition, and the high speed semiconductor laser drive stabilized as a result can be realized.

[0028]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained.

[0029] The system configuration Fig. of an optical disk record regenerative apparatus is shown in drawing 4. The roll control of the optical disk 1 is carried out in the fixed direction by the spindle motor 2. 3 is an optical pickup for performing record playback of data to an optical disk 1.

[0030] Drawing 5 contains the laser driving gear with the block diagram of an optical pickup 3.

Semiconductor laser 4 outputs laser beam a according to the drive current I_{op} supplied from the laser driving gear 5. Laser beam a outputted from semiconductor laser 4 is made into parallel light with a collimate lens 6, it passes a beam splitter 7 and incidence is carried out to an objective lens 8. With an objective lens 8, a laser beam is condensed and the focus of the condensing spot is carried out to the data-logging side of an optical disk 1.

[0031] The laser beam reflected by the recording surface turns into parallel light with an objective lens 8 again, changes an optical path and is condensed by the beam splitter 7 at a photodetector 9.

[0032] The reflected light of an optical disk 1 is changed into an electrical signal by the photodetector 9, and is inputted into the servo block 10 of drawing 4. Focal control and tracking control are made according to the electrical signal of a photodetector 9.

[0033] b, c, d and e, i.e., focal signal +, which are shown by drawing 4 and drawing 5, focal signal -, tracking

signal +, and tracking signal - are inputted into the servo block 10. With a servo block, a tracking error signal is made from focal error signal and tracking signal + and tracking signal - from focal signal + and focal signal -.

[0034] Current amplification of a focal error signal and the tracking error signal is carried out, they are told to the actuator 11 of an optical pickup 3, and position control is carried out so that the outgoing radiation light of an optical pickup 3 may condense on the recording surface of an optical disk 1.

[0035] Moreover, the focal signals b and c and the tracking signals d and e which are outputted from a photodetector 9 are inputted into the regenerative-signal processing block 12 at coincidence, and the signal component of the high frequency band in a signal is detected as information data currently recorded as a pit on the optical disk.

[0036] In the record signal-processing block 13, modulation, laser power which carries out format conversion and which is shown later, and timing control are performed for external input data to optical disks.

[0037] The Main control block 14 is controlling the above regenerative-signal processing block 13 and the record signal-processing block 12.

[0038] The power and the record mark of semiconductor laser when recording a mark on a phase-change optical disk as an example are shown in drawing 6. The peak power 1 (PEAK1) and the peak power 2 (PEAK2) are the power for forming a record mark on an optical disk 1. The bias power 1 (BIAS1) is the power for eliminating the mark recorded on the substrate. The bias power 2 (BIAS2) is the power for reducing heat are recording of a mark.

[0039] Moreover, about the area which is not recorded, playback power (READ) is always turned on.

[0040] That is, this example means needing a laser power setup of five values for data logging to an optical disk, and playback.

[0041] The block diagram of a semiconductor laser driving gear is shown in drawing 7. A playback power programmed-current input (IINRD), the peak power 1 programmed-current input (IINPK1), the peak power 2 programmed-current input (IINPK2), the bias power 1 programmed-current input (IINBS1), and the bias power 2 programmed-current input (IINBS2) are inputted into the current input buffer section 15 from the record signal-processing block 13, respectively.

[0042] By taking a current input gestalt, a power setting signal can make the impedance of an electrical transmission way small, and makes effect of a noise the minimum in the long transmission line by a flexible cable etc. In addition, as for Above IINRD, and IINPK1, IINPK2, IINBS1 and IINBS2, it is also possible for a current input to take not conditions but a volt input gestalt absolutely.

[0043] Timing signals are a playback power timing signal (RDMD), peak power 1 timing signal (PK1MD+, PK1MD-), peak power 2 timing signal (PK2MD+, PK2MD-), bias power 1 timing signal (BS1MD+, BS1MD-), and bias power 2 timing signal (BS2MD).

[0044] A power timing signal functions as an enable signal to the power programmed current inputted into the current buffer section 15 in a current driving gear.

[0045] The switching timing of the timing signal for realizing laser luminescence shown by drawing 6 is shown in drawing 8. An active state and bias power 2 timing-signal BS2MD are also always active states in record or elimination area between playback power luminescence time amount, and playback power timing signal RDMD seldom needs rapidity as a switching speed. Therefore, in this example, the timing transmission system of the single end is taken about the above-mentioned 2 timing signals, and it is inputted into the single end logic input section 16.

[0046] In drawing 8, BS2MD makes L level the active state. Peak power 1 timing-signal PK1MD, peak power 2 timing-signal PK2MD, and bias power 1 timing-signal BS1MD are a timing signal which needs high-speed switching at the time of record mark formation, take a differential gestalt, and are inputted into the differential logic input section shown in drawing 7 as drawing 8 shows them. The signal after the operation of the control signal of a difference input is defined as follows, respectively.

[0047]

$PK1MD = (PK1MD+) - (PK1MD-)$ (formula 5)

$PK2MD = (PK2MD+) - (PK2MD-)$ (formula 6)

$BS1MD = (BS1MD+) - (BS1MD-)$ (formula 7)

If PK1MD of drawing 8 is taken for an example, PK1MD+ will make an active state the time of H level and PK1MD- being L level. It is possible to cancel a penetration noise component also in the long transmission line by a flexible cable etc. for the data transmission of a differential gestalt. moreover -- since the crossing point of a positive logic input and a negative logic input serves as an edge location of the result of an operation, ***** change of duty arises by voltage variation and the noise -- final difference --

affecting the duty after an operation decreases.

[0048] By the optical disk record approach which adopts as the die length of a record mark the PWM record which gives information, the duty shelf life of a record pulse is very important.

[0049] Under a definition, the relation of I_{op} is indicated to be each control line as follows above.

$I_{op} = G_x (RDMDxIINRD + PK1 MDxIINPK1 + PK2 MDxIINPK2 + BS1MDxIINBS1 + BS2 MDxIINBS2)$ (formula 8)
It becomes. G is gain of a current mechanical component shown in 18 of drawing 7.

[0050] a timing signal be make into a 2 signal differential type, distribute and it depend until it adopt an addition method as the creation of a scale and a semiconductor laser driving signal and finally carry out the addition composition of the improvement in precision by increase the reinforcement for a noise, and in order to deal with and process each element current of small level, it become that it be advantageous in calorific value, a switching characteristic, etc. in the buffer sections 15, 16, and 17 about the record and the elimination actuation which need a rapidity for control timing as mentioned above.

[0051] Drawing 9 and drawing 10 are drawings in which the configuration of the output section 18 of a semiconductor laser current driving gear was simplified and described.

[0052] Drawing 9 shows the method which supplies the drive current I_{op} in the direction sucked out of the cathode side of semiconductor laser 4, and drawing 10 shows the method which supplies the drive current I_{op} in the direction slushed from the anode side of semiconductor laser 4.

[0053] The laser drive current I_{op} is several 100mA order, and depends the great portion of power consumed on an optical pickup on the laser drive current I_{op} . The power consumption on an optical pickup 3 is $P = VCC \times I_{op}$. (formula 9)

It can come out and express. VCC is supply voltage, and when VCC varies in the largest direction, power consumption serves as max. The items of VCC are the operating voltage V_{op} of semiconductor laser 4, and the operating voltage V_d of the drive output section 18 as they are shown in drawing 9, and they are $VCC = V_{op} + V_d$. (formula 10)

It becomes. Although it is common to be transmitted by the flexible cable 20 from a main part 19 as VCC is shown in drawing 11, and the voltage drop on a flexible cable etc. is considered, in this example, it is omitting for simplification. In addition, the regenerative-signal processing block 12, the record signal-processing block 13, the control block, etc. are mounted in the main part 19.

[0054] Moreover, the operating voltage V_{op} of semiconductor laser 4 changes with the operating currents I_{op} rather than is fixed. Generally it is diode voltage V_{ld} , the internal resistance R_s , then $V_{op} = V_{ld} + I_{op} \times R_s$ in semiconductor laser. (formula 11)

It is expressed. As mentioned above, it is if a formula 9 is rewritten. $P = (V_{op} + V_d) \times I_{op}$ (formula 12)
 $= V_{ld} + I_{op} \times R_s + V_d \times I_{op}$ (formula 13)

It becomes.

[0055] The relation of the drive current I_{op} is indicated to be the output light power of semiconductor laser 4 to drawing 12.

[0056] Semiconductor laser emits light in the power proportional to the drive current I_{op} by making differential effectiveness η into an inclination to the current more than a threshold current I_{th} . The above-mentioned property of semiconductor laser changes with degradation of operating environment temperature and the component by long duration use.

[0057] Although it is the graph which I_{th1} and η_1 are ordinary temperature, respectively, and showed the relation of the output laser power pair drive current of the initial state of duration of service, the time of an elevated temperature, or after prolonged use, it shifts to the graph shown by I_{th2} and η_2 . That is, a drive current value required to carry out outgoing radiation of the fixed laser power P_1 is set to I_{op1} by the former, and is set to I_{op2} ($I_{op1} < I_{op2}$) by the latter. Generation of heat of the laser driving gear 5 increases, and the temperature of semiconductor laser 4 rises as the formula 4 showed from the formula 2, when the drive current I_{op} increased. If temperature rises, there will be a possibility of leading to vicious circle of needing the still bigger drive current I_{op} , and power-saving on an optical pickup 3 will become important.

[0058] Although it is more effective in power saving of an optical head than a formula 9 and a formula 13 to make the drive current I_{op} small, the dependence to a semiconductor laser component is high, and control is difficult for a semiconductor laser drive current, the temperature characteristic, and secular change.

[0059] Therefore, power-saving becomes possible by controlling VCC from a formula 9, i.e., controlling the electrical potential difference V_d built over the laser driving gear output section from a formula 12.

[0060] Drawing 13 and drawing 14 are the circuits of the laser driving gear output section which incorporated the above-mentioned power-saving. Drawing 13 shows the case where it is based on the laser drive approach of the method which pulls out the drive current I_{op} from the cathode side of the semiconductor laser 4 shown by drawing 9. The electrical-potential-difference detecting element 21

detects the collector voltage of the transistor 18 of the laser driving gear output section.

[0061] It is DC at the time of playback, and at the time of elimination, the collector current of a transistor 18 is a pulse-like at the time of record, and it is [it is a pulse-like or] DC. Therefore, the gate mold electrical-potential-difference detection equipment which synchronized with the period when the drive current of the peak power 2 at the time of record, the bias power 1 at the time of elimination, and each lead power at the time of playback is flowing as one example as an electrical-potential-difference detecting element 21 is suitable.

[0062] The output signal of the electrical-potential-difference detecting element 21 is the electrical-potential-difference comparator 22, it is compared with the electrical potential difference of the source 23 of reference voltage, and a comparison result is fed back to the power supply section transistor 24, and the collector voltage of a transistor 18 is always controlled by this example by the fixed electrical potential difference in each at the time of record, elimination, and playback.

[0063] If the collector voltage of a transistor 18 is set as the minimum value at the minimum value which can be operated, i.e., the range which does not carry out bottoming saturation, the calorific value in the laser drive current-output section is maintainable to min.

[0064] The above can also change the source 23 of reference voltage to the optimal value to each mode of record, elimination, and playback, although the source 23 of reference voltage is made into the fixed electrical potential difference.

[0065] Drawing 14 is the example which incorporated power-saving in the laser drive approach of the method which slashes the drive current I_{op} from the anode side of the semiconductor laser 4 shown by drawing 10. The electrical-potential-difference detecting element 21 detects the collector voltage of the drive transistor 18 like the case of drawing 13, and the output of the electrical-potential-difference detecting element 21 is compared with the electrical potential difference of the source 23 of reference voltage by the electrical-potential-difference comparator 22, and feeds back the result to the power supply section transistor 24.

[0066] Since the emitter electrical potential difference of the power supply section transistor 24 is the supply voltage of an optical disk unit, it produces variation, but since the source 23 of reference voltage consists of what has few voltage variation called a band gap, its collector voltage of a transistor 18 is stable in drawing 13, also to a source effect.

[0067] Fluctuation part ΔPP of the power consumption of the transistor 24 by fluctuation part ΔVCE of collector voltage VCE of the power supply section transistor 24 is $\Delta PP = \Delta VCE \times I_{op}$ (formula 14)

It becomes. Therefore, the power supply section transistor 24 brings a result which drives away a heat source to a main part from on an optical pickup also to a part for the line voltage variation of an optical disk unit by arranging in the location 19 separated from the optical pickup, for example, the main part shown in drawing 11.

[0068] VCC shown by the formula 9 serves as a collector voltage of the power supply section transistor 24, and is a collector voltage VC, then $P = V_C \times I_{op}$ (formula 15)

On the other hand, since it is $V_C = V_{op} + V_d$, it is from a formula 14. $P = (V_{op} + V_d) \times I_{op}$ (formula 16)
 $= V_{Id} + I_{op} \times R_s + V_d \times I_{op}$ (formula 17)

It becomes. Since V_{op} , V_{Id} , and R_s are the values of semiconductor laser 3 proper and do not change, it turns out that the power consumption P of an optical pickup 3 is not influenced of a source effect.

[0069] Moreover, reduction of the power consumption on an optical head is attained a passage clear from formulas 16 and 17 by adjusting the electrical potential difference of the source 23 of reference voltage so that the laser driving gear output section electrical potential difference V_d may serve as the minimum value which can be operated.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

- [Drawing 1] Drawing showing the record pulse shape and the record mark of an optical disk
- [Drawing 2] Drawing showing a wave when a "provincial accent" occurs to a record pulse and the amplitude falls, and the example of a record mark
- [Drawing 3] The related Fig. of semiconductor laser, the capacity which is parasitic on the conductor between semiconductor laser mechanical components, and the pulse-shape build up time T_r and a fall time T_f
- [Drawing 4] Optical disc system block diagram
- [Drawing 5] Optical pickup block diagram
- [Drawing 6] An optical disk record mark and the Fig. corresponding to semiconductor laser power
- [Drawing 7] Semiconductor laser driving gear block diagram
- [Drawing 8] The Fig. corresponding to semiconductor laser power and a timing signal
- [Drawing 9] Laser driving gear output section block diagram
- [Drawing 10] Laser driving gear output section block diagram
- [Drawing 11] Optical head plot plan
- [Drawing 12] The output-power pair drive current Fig. of semiconductor laser
- [Drawing 13] Power-saving laser driving gear output section block diagram
- [Drawing 14] Power-saving laser driving gear output section block diagram

[Description of Notations]

- 1 Optical Disk
 - 2 Spindle Motor
 - 3 Optical Pickup
 - 4 Semiconductor Laser
 - 5 Laser Driving Gear
 - 6 Collimate Lens
 - 7 Beam Splitter
 - 8 Objective Lens
 - 9 Photodetector
 - 10 Servo Block
 - 11 AKUCHIEETA
 - 12 Regenerative-Signal Processing Block
 - 13 Record Signal-Processing Block
 - 14 Main Control Block
 - 15 Current Input Buffer Section
 - 16 Single End Logic Input Section
 - 17 Differential Logic Input Section
 - 18 Laser Driving Gear Output Section
 - 19 Main Part
 - 20 Flexible Cable
 - 21 Electrical-Potential-Difference Detecting Element
 - 22 Electrical-Potential-Difference Comparator
 - 23 Source of Reference Voltage
 - 24 Power Supply Section Transistor
- Laser beam

- b Focal signal +
- c Focal signal -
- d Tracking signal +
- e Tracking signal -

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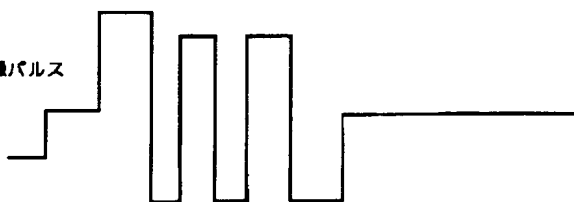
DRAWINGS

[Drawing 1]

記録マーク

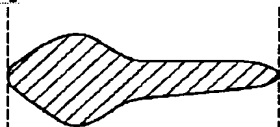


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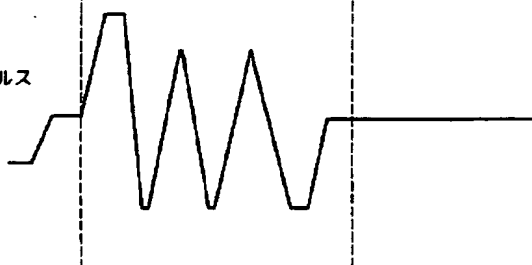


[Drawing 2]

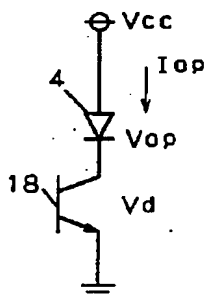
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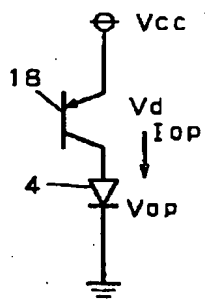
記録パルス



[Drawing 9]

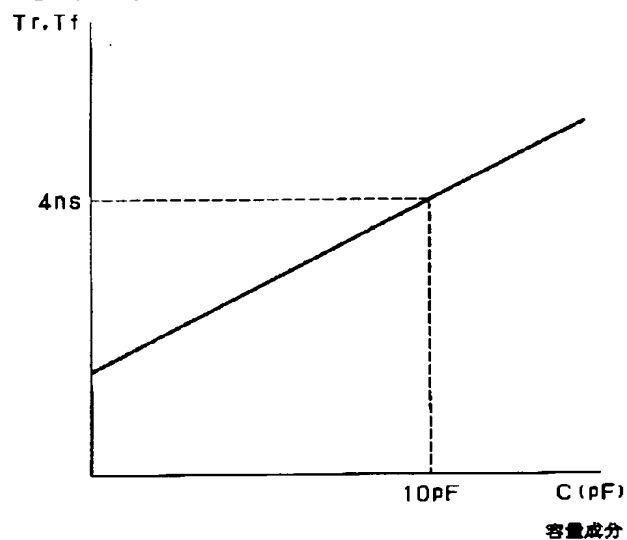


[Drawing 10]

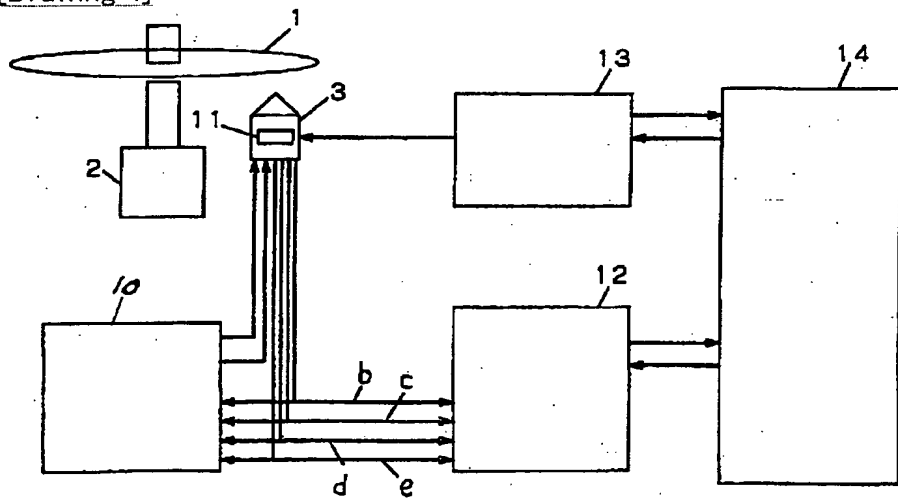


[Drawing 3]

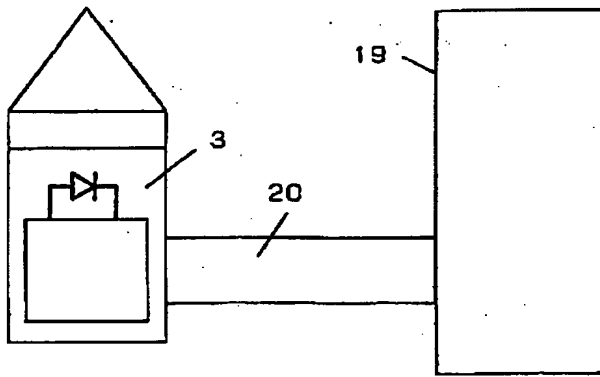
立ち上がり立ち下がり時間



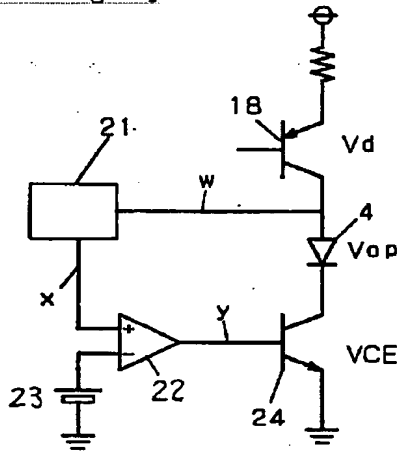
[Drawing 4]



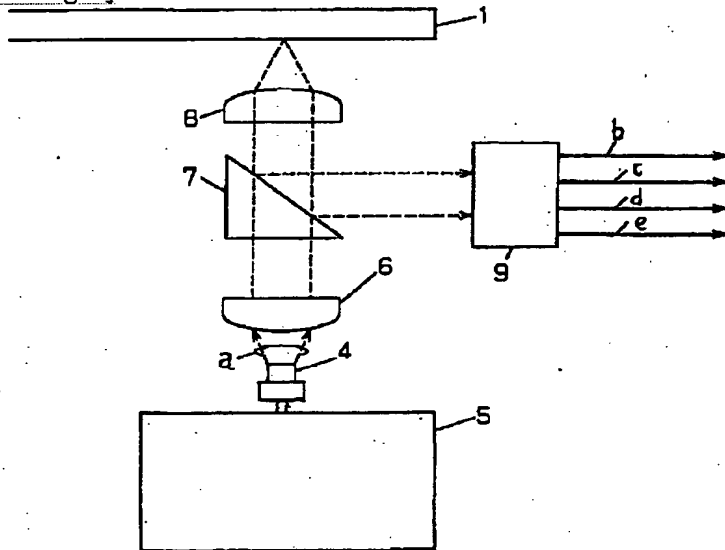
[Drawing 11]



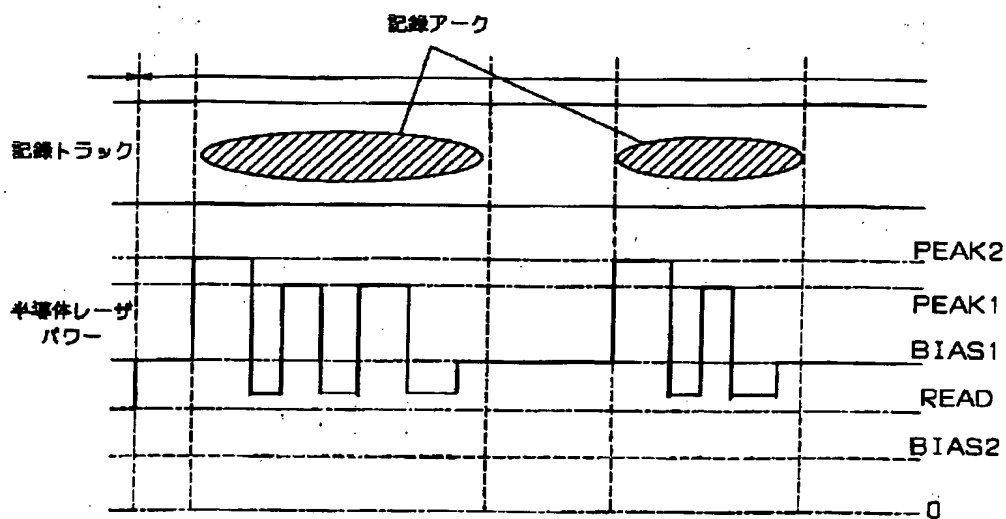
[Drawing 14]



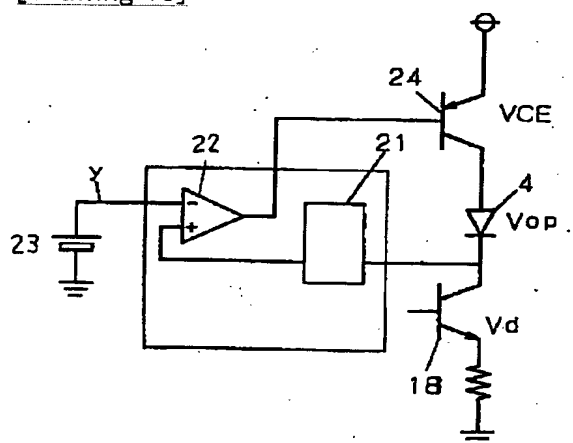
[Drawing 5]



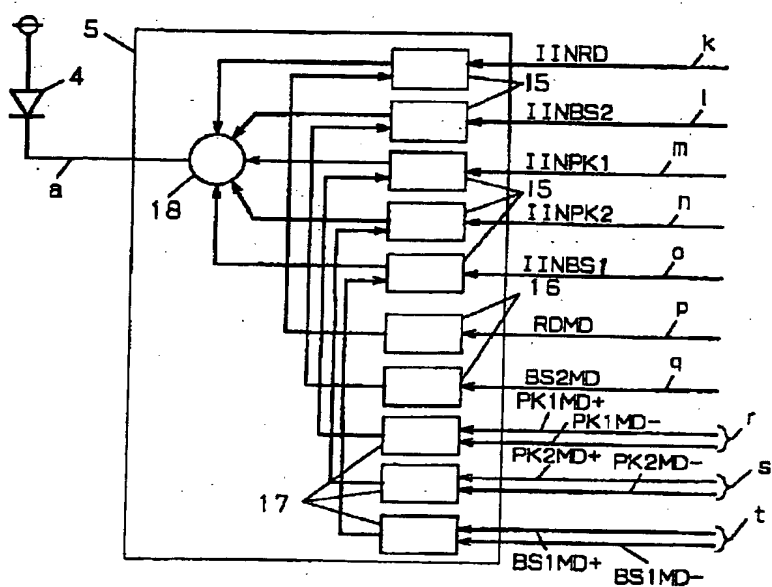
[Drawing 6]



[Drawing 13]



[Drawing 7]



[Drawing 8]

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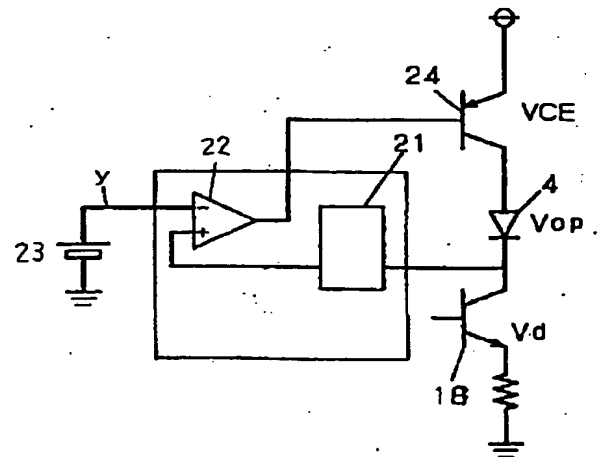
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(54)【発明の名称】 半導体レーザ駆動装置及び駆動方法

(57)【要約】

【課題】 半導体レーザを搭載した光ピックアップと半導体レーザ駆動装置が分離している方式では、普通、半導体レーザの駆動電流をフレキシブルケーブル等で伝送する。この際、フレキシブルケーブルの寄生容量等によって駆動電流のスイッチング特性が悪化する。

【解決手段】 半導体レーザ駆動部を光ピックアップ上に搭載した構成をとる。この構成では、レーザ駆動電流のために駆動部は熱源となり、光ピックアップの温度上昇を招く。即ち駆動部の省消費電力化が必要である。本案の構成としては、半導体レーザパワー設定用のN個の入力信号と、各電流入力値を選択する切り替えタイミング信号入力を設けたレーザ駆動装置で、駆動装置の出力部へ供給する電圧が駆動出力部動作可能最小電圧となるように電源部の電圧を制御する。又電源部は光ピックアップ以外の場所に設定する。



【特許請求の範囲】

【請求項 1】 光ディスクを使用してデータの再生およびデータの記録を行うための半導体レーザ駆動装置で、半導体レーザをパルス状に光変調する時の最高周波数 f ($f > 0$) に対して、前記光変調波形の立ち上がり時間 T_a ($T_a > 0$) と立下り時間 T_b ($T_b > 0$) の関係が $T_a < 0.5 \times 0.5 \div f$ 、 $T_b < 0.5 \times 0.5 \div f$ となるように前記半導体レーザ駆動装置と前記半導体レーザとの間の距離 L を $5 \text{ cm} > L > 0$ の条件に近接することを特徴とする半導体レーザ駆動装置。

【請求項 2】 前記半導体レーザ駆動装置は光ピックアップと同じ可動部に搭載されていることを特徴とする請求項 1 記載の半導体レーザ駆動装置。

【請求項 3】 前記半導体レーザ駆動装置は N 個 (N は自然数) のレーザパワー設定信号入力部と前記 N 値のレーザパワー設定信号を各々選択するための N 個の切り替えタイミング信号入力部と前記切り替えタイミング信号にて選択された P 個 (P は N 以下の自然数) のレーザパワー設定信号を加算するための信号加算部と前記信号加算部によって加算された P 個の前記レーザパワー設定信号に応じて、半導体レーザに駆動電流を供給する電流源とを有する請求項 2 記載の半導体レーザ駆動装置。

【請求項 4】 前記 N 個のレーザパワー設定信号は電流入力形態をとることを特徴とする請求項 3 記載の半導体レーザ駆動装置。

【請求項 5】 前記 N 個の切り替えタイミング信号入力手段のうち M 個 (M は N 以下の自然数) のタイミング信号入力部は差動型の入力形態を有することを特徴とする請求項 3 記載の半導体レーザ駆動装置。

【請求項 6】 前記半導体レーザ駆動装置の半導体レーザ駆動出力部にかかる電圧値を基準値と比較し、一定値に制御するための、電源部と電源部の電圧制御部とを有する請求項 3 記載の半導体レーザ駆動装置。

【請求項 7】 前記半導体レーザ駆動装置出力部にかかる電圧値が前記半導体レーザ駆動装置出力部の動作可能最小値となるように前記電源部を制御することを特徴とする請求項 6 記載の半導体レーザ駆動装置。

【請求項 8】 前記電源部は前記光ピックアップと同じ可動部外に設けられている事を特徴とする請求項 6 記載の半導体レーザ駆動装置。

【請求項 9】 光ディスクを使用してデータの再生およびデータの記録を行うための半導体レーザ駆動方法で、半導体レーザをパルス状に光変調する時の最高周波数 f ($f > 0$) に対して、前記光変調波形の立ち上がり時間 T_a ($T_a > 0$) と立下り時間 T_b ($T_b > 0$) の関係が $T_a < 0.5 \times 0.5 \div f$ 、 $T_b < 0.5 \times 0.5 \div f$ となるように前記半導体レーザ駆動装置と前記半導体レーザとの間の距離 L を $5 \text{ cm} > L > 0$ の条件に近接することを特徴とする半導体レーザ駆動方法。

【請求項 10】 前記半導体レーザの電流駆動部は前記

半導体レーザと同じく前記光ピックアップと同じ可動部に搭載されていることを特徴とする請求項 9 記載の電流駆動方法。

【請求項 11】 前記電流駆動方法で N 個 (N は自然数) のレーザパワー設定信号を入力し、前記 N 個のレーザパワー設定信号を N 個の切り替えタイミング信号で選択し、前記選択された P 個 (P は N 以下の自然数) のレーザパワー設定信号を加算し、前記加算された設定信号に応じた駆動電流を前記半導体レーザに供給する請求項 10 記載の半導体レーザ駆動方法。

【請求項 12】 前記 N 値のレーザパワー設定信号を電流入力とすることを特徴とする請求項 11 記載のレーザパワー駆動方法。

【請求項 13】 前記 N 個の切り替えタイミング信号のうち M 個 (M は N 以下の自然数) の切り替えタイミング信号を差動信号によって伝送することを特徴とする請求項 11 記載の半導体レーザ駆動方法。

【請求項 14】 前記半導体レーザ駆動出力部の電圧を観測し、前記観測値をもとに前記半導体レーザと駆動出力部に電流を供給する電源部の電圧を制御し前記半導体レーザ駆動出力部の電圧を一定電圧となるよう制御する請求項 11 記載の半導体レーザ駆動方法。

【請求項 15】 前記半導体レーザ駆動出力部への供給電圧を前記駆動出力部の動作可能最小値となるよう制御する請求項 14 記載の半導体レーザ駆動方法。

【請求項 16】 前記電源部は前記光ピックアップと同じ可動部外の領域に設けられ、光ピックアップと同じ可動部に搭載された半導体レーザ及び半導体レーザ電流駆動部に電流を供給する事を特徴とする請求項 14 記載の半導体レーザ駆動方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、光ディスク装置の光ピックアップに搭載されている半導体レーザ制御に関するものである。

【0002】

【従来の技術】 光ディスク装置は光ピックアップに搭載された半導体レーザを発光し、再生時にはディスク上に微弱な再生光を集光し、ディスク上に記録されているピットの反射率、位相差、偏向角などを検出し読みとり、記録時には再生時より高いパワーで半導体レーザを発光させ、記録する情報に応じてレーザパワーを変調してディスク上に記録し、消去時には記録時にほぼ近いレーザパワーをディスク上に照射し記録部を消去する。

【0003】 例えば相変化型光ディスクへの記録の場合は、基本的にはピークパワーとバイアスパワーの 2 値をスイッチングし、ピークパワー部でマークを記録し、バイアスパワー部で記録マークの消去を行う。

【0004】 しかし実際には安定した記録マークを形成するためには 2 値のスイッチングでは不足であり、図 1

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に示すとおり、記録すべきマークに対し加えられる熱量を均一化する目的やマーク始末端部の熱バランスを調整する目的のために2値以上の複数値のレーザパワースイッチングが必要である。

【0005】近年光ディスクの記録再生も高速化してきており上記半導体レーザのスイッチング動作にも、より高速性が必要とされる様になってきた。

【0006】高速記録時において図1に示す記録パルスを実現しようとした時に半導体レーザのパルス波形が十分に高速化されていない場合は、図2に示すようにレーザパワーが所望の波高値まで到達せず、記録マークへの熱量アンバランスが生じ記録マークが歪んでしまう。

【0007】又、記録マークの前後エッジに情報を持つPWM記録においては、記録マークのエッジ位置を正確にコントロールする必要があるために、記録パルスの立ち上がり、立下り時間がより短い記録パルスが要求されている。

【0008】

【発明が解決しようとする課題】従来採用されている半導体レーザを搭載した光ピックアップと半導体レーザ駆動装置が分離している方式では、普通、半導体レーザの駆動電流をフレキシブルケーブル等で伝送する。この場合、フレキシブルケーブルの寄生容量等の分布定数によ

$$T_r < 0.5 \times 0.5 / f_1$$

となる。

【0014】例えば最高周波数=60MHzのパルススイッチング実現のためには式1より T_r 及び T_f は共に4.16ns以下であることが要求される。

【0015】図3に示す実験結果からは、 T_r 、 $T_f < 4.16ns$ を実現するためには寄生容量成分を10pF以下が必要であると言える。当条件を満たすためには半導体レーザとレーザ駆動部間の距離を5cm以内に近接化することが必要である。

【0016】従って高速レーザスイッチングを達成するためにはレーザ駆動装置と半導体レーザ間の分布定数、主に容量成分を低減する目的で、レーザ駆動装置と半導体レーザ間を近接させる、すなわち半導体レーザが組み込まれている光ピックアップ上にレーザ駆動装置を搭載することが必要となる。又は、光ピックアップと同じ可動部にレーザ駆動装置を付設することが必要となる。ただしこの場合問題となるのは半導体レーザとレーザ駆動装置から発生する熱の問題である。

【0017】光ディスクへのデータ記録時、半導体レー

$$T_{1d} = K_2 \times V_{op} \times I_{op} + K_3 \times K_1 \times V_d \times I_{op} \quad (\text{式4})$$

となる。

【0021】

【課題を解決するための手段】以上の問題点の解決手段として駆動電流 I_{op} の抑制、比例定数 K_1 、 K_2 、熱伝導率 K_3 の抑制、駆動装置出力部にかかる電圧 V_d 、 V_{1d} の抑制が考えられる。

って駆動電流のスイッチング特性が悪化する。

【0009】即ち、このスイッチング特性の悪化が光ディスク装置を高速化するに際しての弊害となる。

【0010】本発明は上記弊害に対する改善と、改善に伴い発生する熱集中化の問題を解決するための省電力化に関するものである。

【0011】図3は、光ディスク装置の半導体レーザと駆動装置間の導体等に寄生する容量成分と、半導体レーザをパルス状にスイッチングした時の半導体レーザ駆動電流の立ち上がり時間 T_r 、立下り時間 T_f の関係を示す。

【0012】上記容量成分に着目すれば、容量成分が増加するに従って、伝送されるパルス電流の高周波成分が半導体レーザに伝送される前に容量を介してバイパスされ、半導体レーザの駆動パルス波形の立ち上がり時間 T_r 、立下り時間 T_f が大きくなる。すなわち図2に示したような鈍った記録パルスに近づいてくる。

【0013】仮に、半導体レーザ駆動パルスにおいて最高周波数 f_1 のパルスが必要とされるとすれば、パルス幅は $0.5/f_1$ が最小パルス幅となる。従って周波数 f_1 のパルスにおいて、駆動パルスの振幅低下がない条件とは

$$T_f < 0.5 \times 0.5 / f_1 \quad (\text{式1})$$

ザ駆動電流 I_{op} は数100mAに達し駆動装置出力部にかかる電圧を V_d 、比例定数を K_1 とすると

$$T_d = K_1 \times V_d \times I_{op} \quad (\text{式2})$$

の温度上昇が駆動装置に発生する。

【0018】前述したとおりレーザ駆動装置と半導体レーザとは寄生容量等分布定数の影響を小さくするために近接して配置する必要があるため駆動装置で発生した熱は半導体レーザにも伝導する。

【0019】半導体レーザの駆動特性は温度によって大きく異なり、高温となるほど駆動電流 I_{op} に対するレーザ発光パワー P の関係(微分効率)は悪化し、より多くの駆動電流 I_{op} が必要となり、更に式1から駆動装置の温度上昇を加速させる。

【0020】又、半導体レーザはそれ自体が発熱源であり、半導体レーザの動作電圧を V_{op} 、比例定数を K_2 とすれば

$$T_{1d} = K_2 \times V_{op} \times I_{op} \quad (\text{式3})$$

の温度上昇となる。つまり駆動回路から半導体レーザへの熱の伝導率を K_3 とすれば半導体レーザの温度上昇は

【0022】 I_{op} は半導体レーザ固有の特性であり、比例定数 K_1 、 K_2 、 K_3 は光ピックアップ構成、及び熱設計に依存する。又 V_{op} も駆動電流 I_{op} によって変動するが、変動量はダイオード電圧と内部直列抵抗によって決まり、基本的に半導体レーザ固有の値である。

【0023】従ってレーザ駆動装置出力部にかかる電圧

Vdを抑制するすることで光ヘッド部の発熱を抑制する。

【0024】Vdを抑制するため、レーザ駆動装置出力部に供給する電圧を制御する電源部を設けレーザ駆動装置出力部の電圧を監視し、基準となる電圧と比較しその差分を電源部へフィードバックすることで、常にVdが一定値を保ち得る様に制御し、更にレーザ駆動装置出力部が駆動動作可能範囲内でVdが最小値になるように電源部の電圧を設定する。

【0025】上記電源部は半導体レーザ及び半導体レーザ駆動装置が搭載されている光ピックアップ以外の場所に設置する。即ち半導体レーザ部に熱的に関与しない場所に余剰発熱部を隔離する。

【0026】さらにACライン電圧の変動、負荷の変動、及びその他バラツキなどで光ディスク装置の電源電圧が変動しても常に半導体レーザ駆動装置出力部のVdは一定に保たれ光ピックアップ内での発熱はこれらの変動には関係しなくなる。

【0027】この様にしてレーザ駆動装置出力部にかかる電圧Vdを動作可能最低電圧に保つことで光ピックアップ部での発熱を常に最小状態に制御することが出来、結果として安定した高速化半導体レーザ駆動が実現し得ることになる。

【0028】

【発明の実施の形態】以下、本発明の実施形態について説明する。

【0029】図4に光ディスク記録再生装置のシステム構成図を示す。光ディスク1はスピンドルモータ2によって一定方向に回転制御されている。3は光ディスク1にデータの記録再生を行うための光ピックアップである。

【0030】図5は光ピックアップ3の構成図でレーザ駆動装置を含んでいる。半導体レーザ4はレーザ駆動装置5より供給される駆動電流Iopによりレーザ光aを出力する。半導体レーザ4より出力されたレーザ光aはコリメートレンズ6により平行光とされ、ビームスプリッタ7を通過し対物レンズ8に入射される。対物レンズ8によってレーザ光は集光され、集光スポットは光ディスク1のデータ記録面にフォーカスされる。

【0031】記録面で反射されたレーザ光は再び対物レンズ8により平行光となり、ビームスプリッタ7によって光路を変更しフォトディテクタ9に集光される。

【0032】フォトディテクタ9によって光ディスク1の反射光は電気信号に変換され、図4のサーボブロック10に入力される。フォトディテクタ9の電気信号に応じて、フォーカス制御、トラッキング制御がなされる。

【0033】図4、図5で示すb、c、d、e即ちフォーカス信号+、フォーカス信号-、トラッキング信号+、トラッキング信号-はサーボブロック10に入力される。サーボブロックではフォーカス信号+、フォーカ

ス信号-からフォーカス誤差信号、トラッキング信号+、トラッキング信号-からトラッキング誤差信号が作られる。

【0034】フォーカス誤差信号、トラッキング誤差信号は電流増幅され光ピックアップ3のアクチュエータ11に伝えられ、光ピックアップ3の出射光が光ディスク1の記録面上に集光するように位置制御される。

【0035】また、フォトディテクタ9から出力されるフォーカス信号b、c、トラッキング信号d、eは同時に再生信号処理ブロック12に入力され信号中の高周波帯の信号成分は光ディスク上にピットとして記録されている情報データとして検出される。

【0036】記録信号処理ブロック13では外部入力データを光ディスク用に変調、フォーマット変換し、後で示すレーザパワー、タイミング制御を行う。

【0037】メインコントロールブロック14は以上の再生信号処理ブロック13、記録信号処理ブロック12を制御している。

【0038】図6には例として相変化型光ディスクにマークを記録するときの半導体レーザのパワーと記録マークを示している。ピークパワー1(PEAK1)、ピークパワー2(PEAK2)は光ディスク1上に記録マークを形成するためのパワーである。バイアスパワー1(BIAS1)は下地に記録されたマークを消去するためのパワーである。バイアスパワー2(BIAS2)はマークの熱蓄積を低減するためのパワーである。

【0039】また、記録しないエリアに関しては、常に再生パワー(READ)がオンになる。

【0040】すなわち、本例では光ディスクへのデータ記録、再生に5値のレーザパワー設定を必要とすることを意味している。

【0041】図7には半導体レーザ駆動装置の構成図を示している。再生パワー設定電流入力(IINRD)、ピークパワー1設定電流入力(IINPK1)、ピークパワー2設定電流入力(IINPK2)、バイアスパワー1設定電流入力(IINBS1)、バイアスパワー2設定電流入力(IINBS2)がそれぞれ記録信号処理ブロック13より電流入力バッファ部15に入力されている。

【0042】パワー設定信号は電流入力形態を取ることによって電送路のインピーダンスを小さくできフレキシブルケーブル等による長い伝送路においてノイズの影響を最小限にする。なお、上記IINRD、IINPK1、IINPK2、IINBS1、IINBS2は電流入力が絶対条件ではなく電圧入力形態をとることも可能である。

【0043】タイミング信号は再生パワータイミング信号(RDMD)、ピークパワー1タイミング信号(PK1MD+)、ピークパワー1タイミング信号(PK1MD-)、ピークパワー2タイミング信号(PK2MD+)、ピークパワー2タイミング信号(PK2MD-)、バイアスパワー1タイミング信号(BS1MD+)、バイアスパワー1タイミング信号(BS1MD-)、バ

イアスパワー 2 タイミング信号 (BS 2 MD) である。

【0044】電流駆動装置内の電流バッファ部 15 に入力されたパワー設定電流に対して、パワータイミング信号はイネーブル信号として機能する。

【0045】図 8 には図 6 で示したレーザ発光を実現するためのタイミング信号のスイッチングタイミングを示したものである。再生パワータイミング信号 R DMD は再生パワー発光時間の間は常にアクティブ状態、バイアスパワー 2 タイミング信号 BS 2 MD も記録または消去エリアにおいては常にアクティブ状態であり、スイッチング速度として高速性をあまり必要としない。したがって本例では上記 2 タイミング信号に関してはシング

$$PK1MD = (PK1MD+) - (PK1MD-) \quad (式5)$$

$$PK2MD = (PK2MD+) - (PK2MD-) \quad (式6)$$

$$BS1MD = (BS1MD+) - (BS1MD-) \quad (式7)$$

図 8 の PK 1 MD を例にとると PK 1 MD + が H レベル、PK 1 MD - が L レベルの時をアクティブ状態とする。差動形態のデータ伝送のためフレキシブルケーブル等による長い伝送路においても進入ノイズ成分をキャンセルすることが可能である。又、正論理入力と負論理入力のクロス点が演算結果のエッジ位置となるために、電圧変動や、ノイズによってデューティーの変化が生じた

$$\begin{aligned} Iop = G \times (& RDMD \times IINRD \\ & + PK1MD \times IINPK1 \\ & + PK2MD \times IINPK2 \\ & + BS1MD \times IINBS1 \\ & + BS2MD \times IINBS2) \end{aligned} \quad (式8)$$

となる。G は図 7 の 18 に示す電流駆動部のゲインである。

【0050】以上の様に制御タイミングに高速性を必要とする記録及び消去動作については、タイミング信号を二信号差動式とし、対ノイズ強度を増すことで精度の向上をはかり、又、半導体レーザ駆動信号の作成には加算方式を採用し、最終的に加算合成するまでの分散されたより小さいレベルの各要素電流を取り扱い処理するためバッファ部 15、16、17 での発熱量及びスイッチング特性等において有利となる。

【0051】図 9、図 10 は半導体レーザ電流駆動装置の出力部 18 の構成を簡略化して記した図である。

【0052】図 9 は半導体レーザ 4 のカソード側から吸い出す方向に駆動電流 Iop を供給する方式を示し、図 10 は半導体レーザ 4 のアノード側から流し込む方向に駆動電流 Iop を供給する方式を示す。

【0053】レーザ駆動電流 Iop は数 100 mA のオーダーであり、光ピックアップ上で消費される電力の大半はレーザ駆動電流 Iop によるものである。光ピックアップ 3 上での消費電力は

$$P = (Vop + Vd) \times Iop \quad (式12)$$

$$= (Vld + Iop \times Rs + Vd) \times Iop \quad (式13)$$

となる。

ルエンドのタイミング伝送方式をとりシングルエンドロジック入力部 16 に入力される。

【0046】図 8 中では、BS 2 MD は L レベルをアクティブ状態としている。ピークパワー 1 タイミング信号 PK 1 MD、ピークパワー 2 タイミング信号 PK 2 MD、バイアスパワー 1 タイミング信号 BS 1 MD は図 8 で示すとおり、記録マーク形成時において高速のスイッチングを必要とするタイミング信号であり差動形態をとり、図 7 に示す差動ロジック入力部に入力される。差動入力の制御信号の演算後の信号をそれぞれ以下のとおり定義する。

【0047】

としても、最終的な差分演算後のデューティーに影響を与えることは少なくなる。

【0048】記録マークの長さに情報を持たす PWM 記録を採用する光ディスク記録方法では記録パルスのデューティー保存性は極めて重要である。

【0049】以上定義のもとで、各制御線と、 Iop の関係を以下のとおりにしめす。

$$P = VCC \times Iop \quad (式9)$$

であらわす事ができる。VCC は電源電圧であって、VCC が最も大きい方向にばらついた時、消費電力が最大となる。VCC の内訳は図 9 に示すとおり、半導体レーザ 4 の動作電圧 Vop と駆動出力部 18 の動作電圧 Vd であり、

$$VCC = Vop + Vd \quad (式10)$$

となる。VCC は図 11 に示すとおりメイン部 19 からフレキシブルケーブル 20 で伝送される事が一般的であり、フレキシブルケーブル上での電圧降下など考えられるが、本例では単純化のため省略している。尚メイン部 19 には再生信号処理ブロック 12、記録信号処理ブロック 13、コントロールブロック等が実装されている。

【0054】又、半導体レーザ 4 の動作電圧 Vop は一定ではなく、動作電流 Iop によって変化する。一般に半導体レーザ内のダイオード電圧 Vld 、内部抵抗 Rs とすれば

$$Vop = Vld + Iop \times Rs \quad (式11)$$

とあらわされる。以上から式 9 を書き換えると

【0055】図 12 には半導体レーザ 4 の出力光パワー

と、駆動電流 I_{op} の関係をしめしている。

【0056】半導体レーザは閾値電流 I_{th} 以上の電流に対して微分効率 η を傾きとして、駆動電流 I_{op} に比例したパワーを発光する。半導体レーザの上記特性は使用環境温度と、長時間使用による素子の劣化によって変化する。

【0057】 I_{th1} 、 η_1 はそれぞれ常温で且つ使用期間の初期状態の出力レーザパワー対駆動電流の関係を示したグラフであるが、高温時または、長期間の使用後には I_{th2} 、 η_2 で示すグラフへと移行する。つまり一定のレーザパワー P_1 を出射するに必要な駆動電流値は前者で I_{op1} 、後者で I_{op2} ($I_{op1} < I_{op2}$) となる。駆動電流 I_{op} が増加すると、式 2 から式 4 で示したとおり、レーザ駆動装置 5 の発熱は増大し、半導体レーザ 4 の温度が上昇する。温度が上昇すればさらに大きな駆動電流 I_{op} を必要とするといった悪循環につながるおそれがあり、光ピックアップ 3 上での省電力化は重要となる。

【0058】式 9、式 13 より光ヘッドの省電力には駆動電流 I_{op} を小さくすることが有効であるが、半導体レーザ駆動電流、温度特性、経年変化は半導体レーザ素子への依存が高く制御が難しい。

【0059】したがって式 9 から V_{CC} を抑制すること、つまり式 12 よりレーザ駆動装置出力部にかかる電圧 V_d を抑制することで省電力化が可能となる。

【0060】図 13、図 14 は上記省電力化を盛り込んだレーザ駆動装置出力部の回路である。図 13 は図 9 で示した半導体レーザ 4 のカソード側より駆動電流 I_{op} を引き出す方式のレーザ駆動方法による場合を示す。電圧検出部 21 はレーザ駆動装置出力部のトランジスタ 18 のコレクタ電圧を検出する。

【0061】トランジスタ 18 のコレクタ電流は記録時はパルス状であり、再生時は DC であり、消去時はパルス状であったり DC であったりする。従って電圧検出部 21 としては、1 例として、記録時のピークパワー 2、消去時のバイアスパワー 1、そして再生時のリードパワーそれぞれの駆動電流が流れている期間に同期したゲート型電圧検出装置が適当である。

【0062】電圧検出部 21 の出力信号は電圧比較部 2

$$P = (V_{op} + V_d) \times I_{op} \quad (\text{式 16})$$

$$= (V_{ld} + I_{op} \times R_s + V_d) \times I_{op} \quad (\text{式 17})$$

となる。 V_{op} 、 V_{ld} 、 R_s は半導体レーザ 3 固有の値であり変化しないため光ピックアップ 3 の消費電力 P も電源変動の影響を受けないことが判る。

【0069】又、基準電圧源 23 の電圧をレーザ駆動装置出力部電圧 V_d が動作可能最小値となるよう調整することで、式 16、17 から明らかとなお光ヘッド上の消費電力の低減が達成される。

【0070】

【発明の効果】以上、本実施例の様にレーザ駆動装置を

2 で、基準電圧源 23 の電圧と比較され、比較結果は電源部トランジスタ 24 にフィードバックされ、本例ではトランジスタ 18 のコレクタ電圧が記録、消去、再生時それぞれにおいて常に一定電圧に制御される。

【0063】トランジスタ 18 のコレクタ電圧を動作可能最小値、即ちボトミング飽和しない範囲で最小値に設定すれば、レーザ駆動電流出力部における発熱量を最小に維持することが出来る。

【0064】以上は基準電圧源 23 を一定電圧としているが基準電圧源 23 を記録、消去及び再生の各モードに対して最適な値に切り替えることも可能である。

【0065】図 14 は図 10 で示した半導体レーザ 4 のアノード側から駆動電流 I_{op} を流し込む方式のレーザ駆動方法に省電力化を盛り込んだ例である。図 13 の場合と同様に駆動トランジスタ 18 のコレクタ電圧を電圧検出部 21 が検出し電圧検出部 21 の出力は、電圧比較部 22 で基準電圧源 23 の電圧と比較され、その結果を電源部トランジスタ 24 にフィードバックする。

【0066】図 13 で、電源部トランジスタ 24 のエミッタ電圧は光ディスク装置の電源電圧であるから、バラツキを生じるが基準電圧源 23 は、例えばバンドギャップといった電圧変動の少ないものから構成されているので電源変動に対してもトランジスタ 18 のコレクタ電圧は安定している。

【0067】電源部トランジスタ 24 のコレクタ電圧 V_{CE} の変動分 ΔV_{CE} によるトランジスタ 24 の消費電力の変動分 ΔP_P は

$$\Delta P_P = \Delta V_{CE} \times I_{op} \quad (\text{式 14})$$

となる。従って電源部トランジスタ 24 は光ピックアップより分離した場所、例えば図 11 に示すメイン部 19 に配置することで光ディスク装置の電源電圧変動分に対しても熱源を光ピックアップ上からメイン部に追いやる結果となる。

【0068】式 9 で示した V_{CC} は電源部トランジスタ 24 のコレクタ電圧となり、コレクタ電圧を V_C とすれば

$$P = V_C \times I_{op} \quad (\text{式 15})$$

一方、 $V_C = V_{op} + V_d$ であるから式 14 から

半導体レーザが組み込まれているピックアップ上に配置し、レーザ駆動装置出力部にかかる電圧 V_d を動作可能最小値に調整することで光ピックアップ上の発熱を最小限に抑えることが出来、多値半導体レーザ電流駆動を安定に高精度に高速化することが可能となる。即ちより高速度な記録再生が実現出来る。

【図面の簡単な説明】

【図 1】光ディスクの記録パルス波形と記録マークを示す図

【図 2】記録パルスに「なまり」が発生し、振幅が低下した場合の波形と記録マーク例を示す図

【図 3】半導体レーザと半導体レーザ駆動部間の導体に寄生する容量と、パルス波形立ち上がり時間 T_r と立下がり時間 T_f との関係図

【図 4】光ディスクシステム構成図

【図 5】光ピックアップ構成図

【図 6】光ディスク記録マークと半導体レーザパワー対応図

【図 7】半導体レーザ駆動装置構成図

【図 8】半導体レーザパワーとタイミング信号対応図

【図 9】レーザ駆動装置出力部構成図

【図 10】レーザ駆動装置出力部構成図

【図 11】光ヘッド配置図

【図 12】半導体レーザの出力パワー対駆動電流図

【図 13】省電力レーザ駆動装置出力部構成図

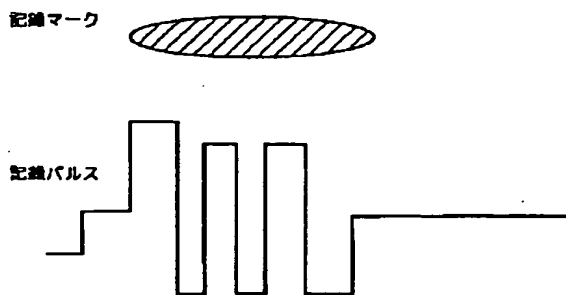
【図 14】省電力レーザ駆動装置出力部構成図

【符号の説明】

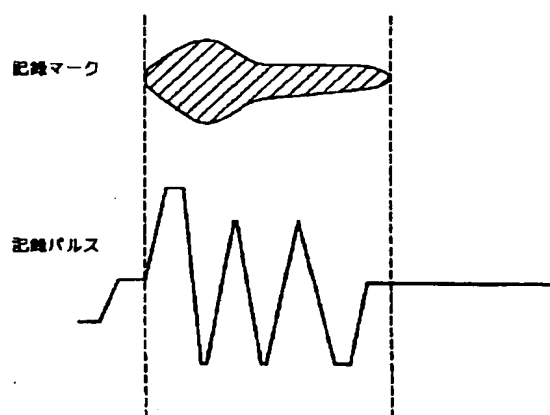
- 1 光ディスク
- 2 スピンドルモータ
- 3 光ピックアップ
- 4 半導体レーザ
- 5 レーザ駆動装置
- 6 コリメートレンズ

- 7 ビームスプリッタ
- 8 対物レンズ
- 9 フォトディテクタ
- 10 サーボブロック
- 11 アクチュエータ
- 12 再生信号処理ブロック
- 13 記録信号処理ブロック
- 14 メインコントロールブロック
- 15 電流入力バッファ部
- 16 シングルエンドロジック入力部
- 17 差動ロジック入力部
- 18 レーザ駆動装置出力部
- 19 メイン部
- 20 フレキシブルケーブル
- 21 電圧検出部
- 22 電圧比較部
- 23 基準電圧源
- 24 電源部トランジスタ
- a レーザ光
- b フォーカス信号+
- c フォーカス信号-
- d トラッキング信号+
- e トラッキング信号-

【図 1】

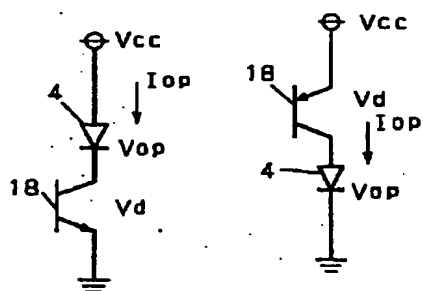


【図 2】

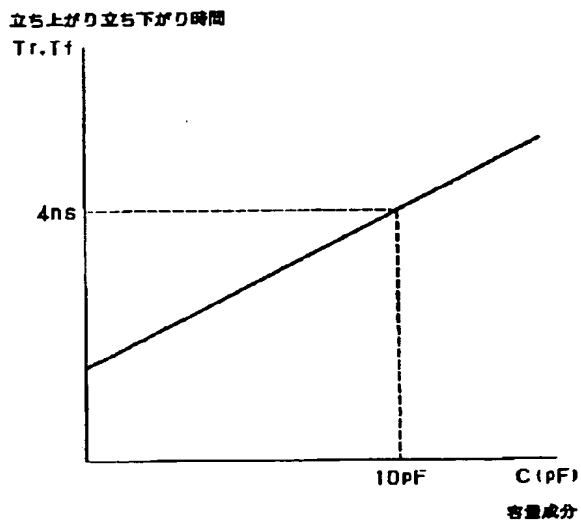


【図 9】

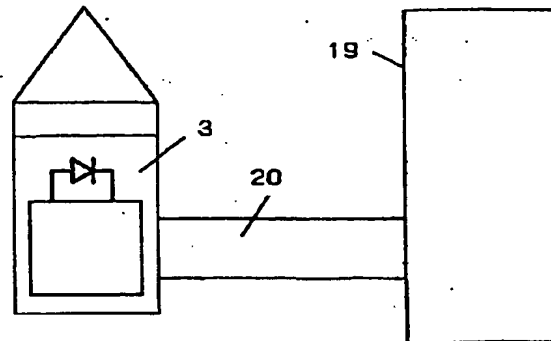
【図 10】



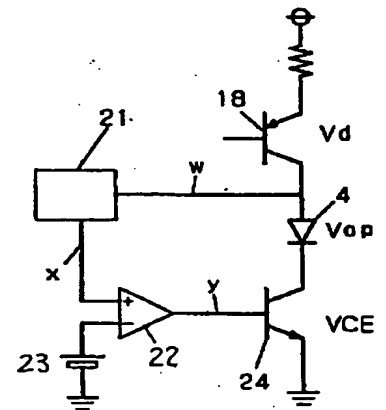
【図3】



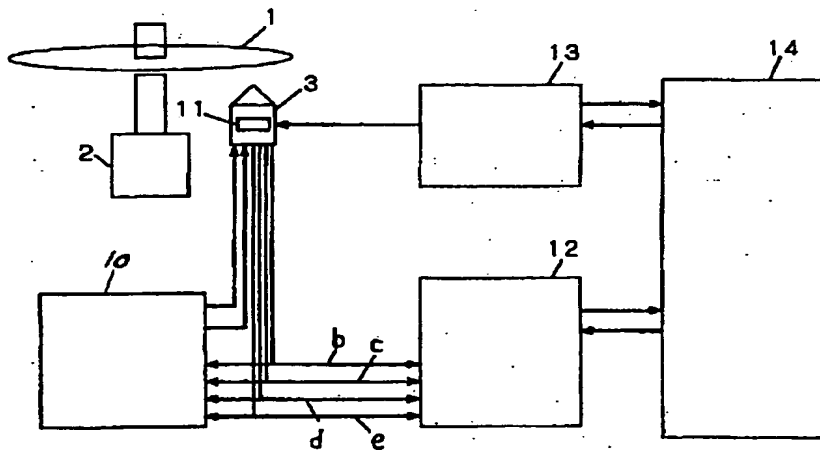
【図11】



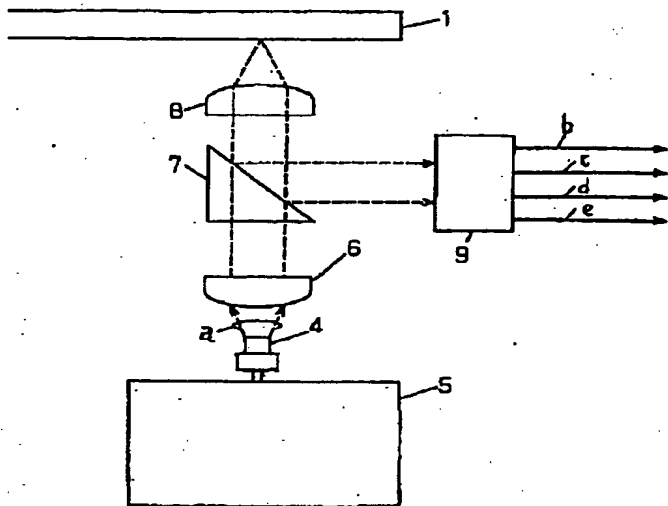
【図14】



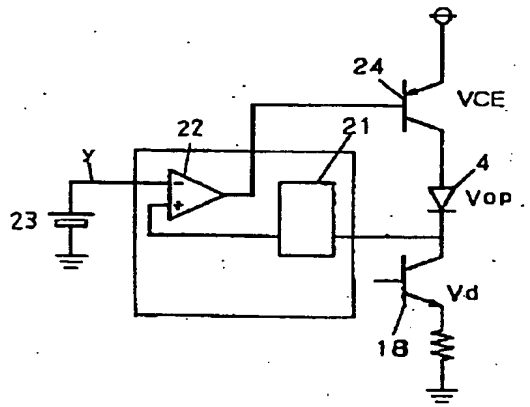
【図4】



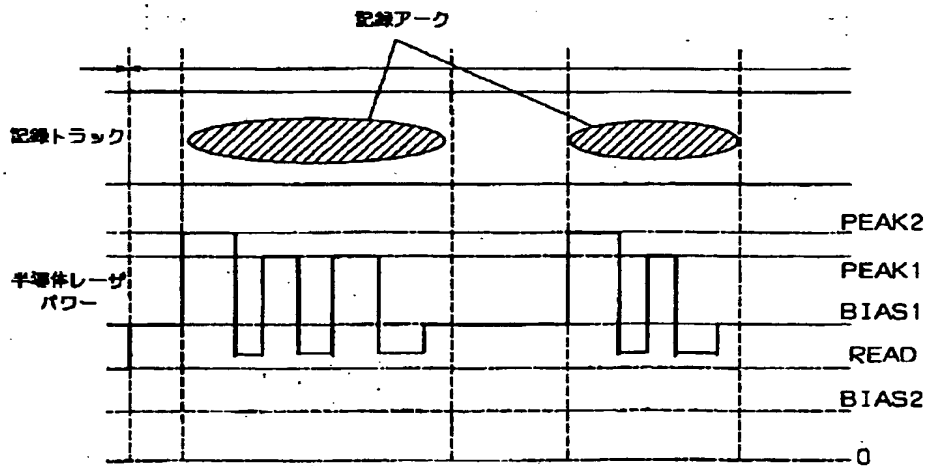
【図5】



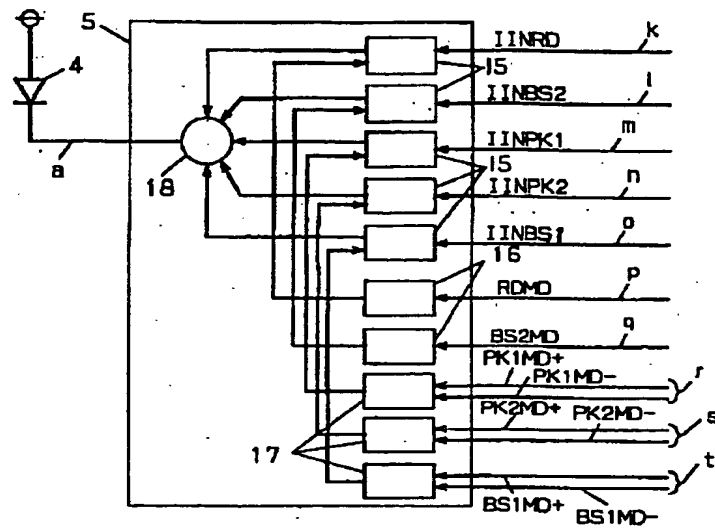
【図13】



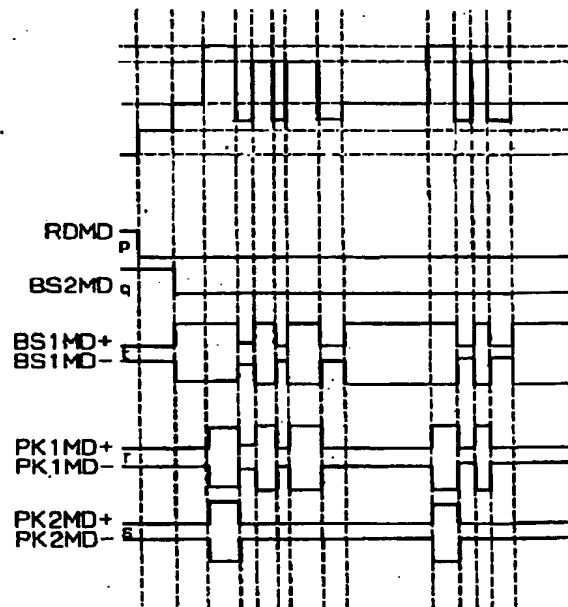
【図6】



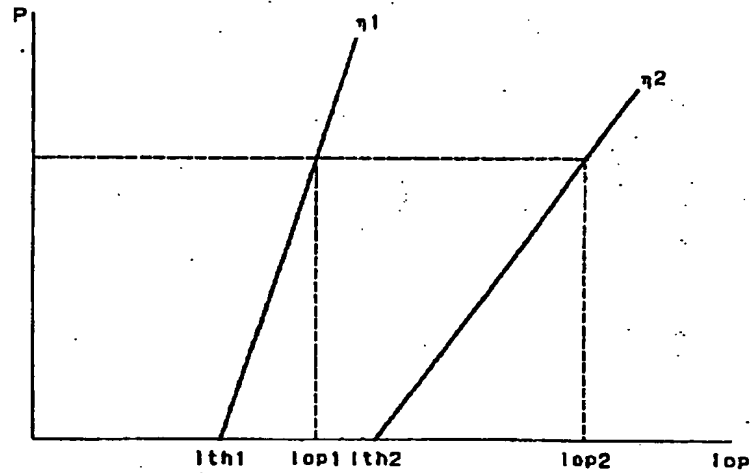
【図7】



【図8】



【図12】



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